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SPACE SUPPORT FOR AIRLAND BATTLE-FUTURE

BY

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SPACE SUPPORT FOR AIRLAND BATTLE-FUTURE

AN INDIVIDUAL STUDY PROJECT

by

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ABSTRACT

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The use of space systems has become a critical component of military strategic, operational, and tactical capabilities. Space forces are employed by the Army to enhance combat support in the functional areas of communications; reconnaissance, surveillance, and target acquisition; weather and environment; and position location and navigation. AirLand Battle-Future doctrine predicts a deep non-linear battlefield environment which will require extensive access to space assets by operational and tactical commanders. This paper postulates that integration of space forces into Army tactical planning and execution will be doctrinally required. The impact of this integration can be described in the context of AirLand Battle tenets and imperatives. If Army officers are to successfully incorporate space forces into campaign and battle planning they must understand what assets are available and how the physics of space influence their employment.

INTRODUCTION

When the subject of space warfare comes up among military professionals, oftentimes there is a conjuring up of "Star Trek" images of Dr. Spock and Captain Kirk battling non-human aliens in distant solar systems. While these imageries may indeed predict the future battlefields of soldiers yet unborn, they presume to take us beyond the battlefield where space forces are most likely to be employed: planet earth.

Within the last three decades, we have seen the evolution of space as a medium alongside land, sea, and air wherein nation states attempt to project force as part of national security strategies. The United States and the Soviet Union have thus far been the dominant users of space, but it is only a matter of time until other nations develop complex civilian and military infrastructures for the use of space.

Space has often been called "the ultimate high ground." It is therefore natural that military tacticians will gravitate toward seeking methods to secure and control this "high ground." The challenges which face military strategists involve developing, deploying, and protecting space systems which enable terrestrial commanders to make maximum use of the space vantage-point.

In the past, most space assets have been considered national assets whose first priority is strategic deterrence. However, the missions and roles of space forces have expanded

over time so that they now perform critical functions in support of operational and tactical commanders. These functions include communications, reconnaissance, surveillance, target acquisition, weather, environment, position location, and navigation.

Given this diversity, space forces should not be viewed as distinct, uniquely functional resources that are always centrally deployed and controlled in support of strategic missions. Rather, they should be considered as another joint force available to an operational commander to extend his terrestrial and maritime battlefields into a spatial medium which allows him to operate, see, and strike deep into non-linear detection and battle areas.

AirLand Battle has been the Army's basic fighting doctrine for the past decade. The fundamentals of this doctrine are described in Army Field Manual (FM) 100-5. This doctrine is constantly being reviewed and revised as the roles, missions, and structure of the Army evolve.

As of this writing, the Army is developing an "AirLand Battle-Future Umbrella Concept" which "focuses on the employment of the Army as the land component of military power in the early part of the 21st century"[1] One of the main focal points of AirLand Battle-Future strategy is an increased emphasis on nonlinear operations to the point where forces preparing for combat are initially deployed in nonlinear configurations on a deep battlefield filled with accurate, lethal weapons.[2]

This concept links Army force capabilities with technological advances which enable forces to be employed for

both combat and noncombat operations based on a global perspective of U.S. interests. The use of space forces is critically important in the development of military strategies in the nonlinear operational environment.

The purpose of this paper is to discuss how operational commanders can integrate space systems into AirLand Battle-Future Doctrine. This will be accomplished by linking existing and proposed space support concepts with the tenets and imperatives of AirLand Battle Doctrine.

SATELLITE SUPPORT SYSTEMS

Space forces are employed by tne Army to enhance performance in the functional areas of communications; reconnaissance, surveillance, and target acquisiton; weather and environment; and position location and navigation. In order to integrate space systems into doctrinal use, it is necessary to understand what space forces are currently available to the AirLand Battle commander and how they are employed to support operational and tactical requirements. In addition, this paper will discuss some of the proposed space systems that may be available in the near future to support the AirLand Battle-Future Umbrella Concept.

COMMUNICATIONS

Communications support for command and control has become a critical function of space forces. Success in executing AirLand Battle doctrine depends on the ability to disseminate orders and

information throughout the depth of the command structure from National through tactical levels.

Military satellite communications (MILSATCOM) systems that are currently deployed include the Defense Satellite Communications System (DSCS), Fleet Satellite Program (FLTSAT), Leased Satellite Program (LEASAT), and the Air Force Satellite Program (AFSAT).[3] The Army is a client rather than an owner of these communications systems. The DSCS system is under the operational control of Army Space Command, but operational support for this and all satellite communications systems is provided to the echelons of national, strategic, operational, and tactical commands on a priority basis.

MILSATCOM satellites operate in three distinct frequency bands. Ultrahigh frequency (UHF) systems operate in the 225-400 MHz range and include the FLTSAT, AFSAT, AND LEASAT systems. Superhigh frequency (SHF) systems are the DSCS II and DSCS III satellites which support the Army's Multichannel Initial System. Also, there is one extremely high frequency (EHF) system currently available on the FLTSAT satellite. An additional EHF Military Strategic Tactical and Relay (Milstar) system is scheduled for use in the mid-1990's by ground forces.[4]

One of the major problems with the current MILSATCOM systems is that Army requirements exceed satellite availability. Because tactical commanders are low in the pecking order of priorities, satellite access generally remains at corps and above levels. Further, theater tactical commanders lack dedicated MILSATCOM support in peace and in war.

Effectiveness of communications systems is limited by availability of satellites, channels, frequency bands, and ground terminals. In the past, most demands have been placed on the UHF systems because they are easiest to use and most compatible with available terminal support. However, ease of UHF operation has resulted in a proliferation of UHF users throughout the military and government communities to the point where there are four times as many potential users as there are channels and frequencies available.[5]

The lack of available UHF systems causes the Army to consider using the SHF systems aboard the DSCS II and DSCS III satellites. Doctrinally, the Army plans for the distribution of ground satellite communications terminals to the division and brigade levels. However, the high costs of the terminals and the lack of available channels have resulted in a reduction in the number of SHF terminals procured by the Army.[6]

Perhaps more critical is the difficulty experienced by the Army in obtaining quality access to SHF channels. "Poor engineering on an SHF SATCOM access link can result in draining satellite antenna power, degradation of other users' circuits on the same channel, loss of anti-jam protection, marginal receive signal at the terminal, and/or achieving the desired data rate. In the anti-jam mode, available channel capacity and data rate are reduced dramatically, making it even more difficult for theater tactical terminals to gain access to the satellites."[7]

The Army is searching for alternate solutions to the problems encountered in UHF and SHF systems by seeking access to

more EHF systems such as the Air Force Military Strategic, Tactical, and Relay Satellite System (MILSTAR). The MILSTAR program, however, may be in jeopardy because of technical problems and extremely high costs. The system was originally designed to provide global jam-resistant communications for tactical nuclear units, intelligence units, and special forces. Support would be provided by a 25 billion dollar system of ten satellites and several thousand ground terminals.[8] Despite reservations about its cost and performance, DOD is requesting that continued funding for MILSTAR be provided in the FY 92 budget.

The Army is forging ahead with upgrades to its communications capabilities. Some battlefield connectivity will be provided by the single-channel objective terminal (SCOTT). The biggest communications program continues to be the fielding of the mobile subscriber equipment (MSE) which supports tactical communications down to the brigade level and connects with the Army multichannel tactical satellite (TACSAT) terminals.

RECONNAISSANCE, SURVEILLANCE, AND TARGET ACQUISITION

Operational planning focuses on analysis of the enemy and his capabilities. A commander's implementation of the principles of war stems from his perception and knowledge of enemy strengths, dispositions, equipment, capabilities, probable intentions, and weaknesses. Reconnaissance and surveillance have long been critical strategic missions of U.S. space forces.

Reconnaissance, surveillance, and target acquisition (RSAT) satellites are operated at the national level. Information gathered by these satellites can be disseminated to Army corps commanders through Army intelligence units. Intelligence and battlefield information provided by space-base assets can be synchronized at the Army operational level through the All Source Analysis System (ASAS).[9]

Examples of national surveillance and reconnaissance assets include the Nuclear Detection Detonation System (NDS), Satellite Early Warning System (SEWS), and the Defense Support Program (DSP). Unfortunately, the strategic missions of space assets limit their accessibility to tactical commanders for battlefield information. Obstacles to tactical integration of these systems include weather induced limitations, such as cloud cover, on satellite performance, lack of timeliness for responses to requests for information, security access restrictions, and higher priorities allocated to other missions.[10]

Operation Desert Storm demonstrated the advantages of integrating the capabilities of space RSAT assets with theater level intelligence gathering systems. For example, Scud missile launches were detected by satellite surveillance systems monitored by U.S. Space Command in Colorado Springs. Launch warnings were then transmitted via satellite communications links to CENTCOM Headquarters in Saudi Arabia. CENTCOM was then able to activate theater air defense warning nets and scramble aircraft to strike at the Scud sites located by the satellites.

WEATHER AND ENVIRONMENT

Combat operations are significantly affected both on the ground and in the air by terrain and weather conditions. Weather affects ground and air mobility, weapons performance, tactical decisions, and the timing of operations. Properly analyzed, weather and its effect on the environment can be used to enhance combat power, provide deception, and increase the element of surprise.

The Army recognizes the need to improve dissemination of weather and environmental data to combat units at least down to brigade level. Enhanced weather prediction capabilities are required due in large part to the effects of weather on high-technology weapons, communications, and surveillance systems. The Army has identified three key needs for space capabilities related to environmental monitoring:

*"Determine weather effects on unit and weapon system effectiveness.

*Provide terrain data for analysis and operational planning.

*Provide integrated weather/terrain effects data."[11]

Weather forecasting is currently provided by meteorological satellites such as the Geostationary Operational Environmental Satellite (GOES) and the Defense Meteorological Satellite Program (DMSP). These systems provide information on wind direction, air moisture, and cloud movement; all of which are essential for accurate prediction of battlefield conditions.

Unfortunately, the tactical commander does not currently have immediate, direct access to terrain data provided by satellites. Environmental data is obtained through commercial and other government satellite programs. LANDSAT is an example of a non-military satellite with considerable potential for providing accurate terrain data to ground and maritime forces.

LANDSAT is a U.S. civil satellite system which provides terrain analysis and trafficability information to the Defense Mapping Agency. The LANDSAT system provides multispectral perspectives of the earth's surface by simultaneously viewing it in several visible and non-visible spectral bands.[12]

LANDSAT offers considerable promise to provide an enhanced capability to generate extremely accurate and timely maps and charts of large ground and oceanic areas. Most importantly, information provided by LANDSAT can be merged with data from other satellites to create three dimensional portraits of pieces of terrain. These data can then be incorporated in the databases of simulators and used to rehearse battlefield maneuvers by individuals and units using real-time images of the terrain and enemy forces which they will encounter.[13]

POSITION LOCATION AND NAVIGATION

AirLand Battle operations are conducted in a highly mobile battlefield environment. Individual and unit navigation and positioning are critical to orienting on objectives and accurately placing fires on the enemy. Position location and navigation (POS/NAV) systems enable units and individuals to

accurately navigate in friendly or hostile environments and provide commanders the means to precisely locate and track forces on the battlefield.

The Army is currently using the Navigation System Using Time and Ranging/ Global Positioning System (NAVSTAR/GPS). This satellite system, when fully deployed in 1992, will consist of 24 satellites, 21 active and three on-orbit spares. It "will provide 3D position and location information to 16 meters spherical error probability (SEP), 10 meters circular error probability, velocity to 0.1 meters/sec, and timing data to tenths of nanoseconds."[14]

The NAVSTAR/GPS system provides electronic navigation aids to ground forces and also provides commanders the means to track locations of forces through the positioning of special transmitters on selected vehicles or equipment. These transmitters enable commanders to penetrate the "fog of battle" to vector forces toward their objectives during periods of limited visibility and under any weather conditions.

Space based POS/NAV systems will enable soldiers to operate in any terrain without fear of getting lost. Additionally, they are valuable assets for surveying data with precise accuracy. Positioning of friendly obstacles and artillery targeting are other examples of force enhancement capabilities inherent in these systems.

SPACE WEAPONS

As space technology evolves, it becomes more evident that deployment of space weapons is becoming a distinct possibility. Arguably, the quest for the military "high ground" of space will logically lead to the use of the medium to directly project combat power just as we have in the terrestrial mediums. The fear of militarization of space, however, has created such concern among governments that there is a very cautious approach to employing space weapons systems.

Nevertheless, research continues on the application of force from space systems. Space weapons can generally be categorized as space-to-earth, space-to-space, and earth-to-space.

Space-to-earth weapons would be the most likely to influence the terrestrial battlefield and could conceivably be integrated into the AirLand Battle concept. Terrestrial structures, vehicles, and equipment could be targeted by a variety of space-based weapons including: (1) continuous wave high energy lasers; (2) pulsed high energy lasers; (3) particle beam weapons; (4) entry vehicles; (5) radio frequency transmitters and sensors; (6) optical/infrared sensors; and (7) radar.[15]

These same technologies could be applied to space-to-space weapons which would target other spacecraft and missiles. The Soviet Union has actually had a space-to-space weapon deployed since 1971. They developed an orbital, antisatellite (ASAT) system which is designed to attack and destroy satellites in low

earth orbit. Although the Soviet system has been described as crude, it nevertheless gives them a space warfare capability unmatched by the U.S.[16]

Conceivably, earth-to-space weapons systems could be the most dangerous and powerful. The flexibility and potential mobility of terrestrial systems can be coupled with much larger sources of energy than are currently available in space. Lasers, particle beam weapons, and ground launched antisatellite missiles can all be employed to locate, track, and destroy manned and unmanned space systems.

Deployment of space-based weapons systems is currently restricted by treaties and is subject to close scrutiny by governments and international agencies. The political nature of this sensitive issue dictates that space related fire support concepts not be pursued so strongly that they exclude the use of space systems for less controversial activities.[17]

However, we cannot ignore the vulnerability of our space systems to current and projected Soviet and other potential adversary antisatellite capabilities. Space is no longer the exclusive domain of the superpowers. In addition to the U.S., USSR, and Western Europe, space payloads have been launched by China, India, and Israel; and, other countries including Brazil and Argentina are developing space launch systems which could be marketed to other nations.[18]

This "proliferation" of space-faring capability raises the spectre of increased use of space for reconnaissance, force enhancement, and force projection by so called Third World

nations. Indeed the "Third World" moniker seems out of place when we are referring to countries who are joining the ranks of space-faring nations who possess the advanced technology needed to access the realm of space.

It would seem unconscionable for the U.S. to assume that the good will of man will prevail and space will not succumb to the proliferation of weapons such as we experienced on land, air, and sea. Certainly, a weapons-free space regime is a noble international goal. However, experience has certainly demonstrated that deterrence goes a long way toward encouraging peaceful behavior among nation states.

The best deterrence on the foreseeable horizon to space weapons proliferation may be the development by the U.S. of an operational ASAT capability to protect our own space systems and to place adversative systems at risk. Development of ASAT weapons has been a contentious issue with the U.S. Congress. However, President George Bush has cited the need to develop and deploy an ASAT capability as part of the National Space Policy. Currently, the Army has been given the lead in a joint effort to develop a ground-based kinetic-energy antisatellite weapon system.[19]

SPACE TERMINOLOGY

Space forces exist for one purpose: to provide support to terrestrial forces. All U.S. military forces utilize space-based support systems to enhance their warfighting capabilities. It is frequently postulated that space will evolve into a future

battlefield with major military operations conducted to protect the force enhancements provided by space systems. Loss of the functions provided by space forces could be catastrophic to the terrestrial forces who rely so heavily on them.

Protection of space assets is a high priority for the military. The Army can be expected to play a major role in any conflict which jeopardizes space control and freedom of action for friendly forces in space.

Unfortunately, Army officers are generally not well versed in the physical characteristics of satellite systems and how these characteristics influence the tenets of space and land warfare. Yet, as the importance of space continues to evolve, it will become increasingly important for terrestrial commanders to understand the environment which tethers the life lines of their space support systems. A primer on some basic characteristics of space systems follows.

SATELLITE ORBITS

Satellites which orbit the earth are given descriptive names based on their types of orbits as follows:

> "ELLIPTICAL--Oval-shaped orbit in which the satellite passes close to the earth at one end and is further from the earth at the other.
>
> CIRCULAR--An orbit in which the satellite remains at essentially the same altitude as it revolves around the earth.
>
> GEOSYNCHRONOUS-- A high altitude orbit, at or above 19,300 mi. Permits a satellite's area of coverage to remain centered on a pre-selected earth longitude.
>
> GEOSTATIONARY--A high altitude geosynchronous orbit which permits a satellite to hover over one point on the equator.

POLAR--An orbit at right angles to the equator which passes over North and South poles.

MOLNIYA--A highly elliptical orbit named for a Soviet communications satellite series, optimized to service northern regions of the USSR.

SUN-SYNCHRONOUS--An orbit which retains a specific relationship to the position of the sun. The satellite views a pre-selected area of the earth every day at the same local time."20

Functional uses of satellites are affected by the altitude and inclination of their orbits. In general, the closer the satellite is to the earth, the higher will be its sensing resolution. This advantage of a low altitude is, however, countered by the facts that low earth orbits provide a more limited field of view and remain over any particular spot on the earth for only a short duration. High altitude orbits, such as geosynchronous, offer the advantage of long dwell time with wide fields of coverage. But, the tradeoff is lower resolution in imaging capabilities.

Inclination refers to the angle which the plane of a satellite's orbit makes with the earth's equatorial plane. The orbital parameters of satellites affect the field of view, or the amount of the earth that a satellite can view at one time. This field of view is also sometimes referred to as "footprint". For example, a geosynchronous satellite which can view 80 degrees north and south from the equatorial plane needs to be inclined only 10 degrees to achieve coverage of all the latitudes. Satellites orbiting the equator with 0 degrees inclination do not cover the higher latitudes; whereas, polar orbits (90 degrees) allow total coverage of the globe as the earth rotates.[21]

The physical properties of orbits influence the types of satellites which we employ in the various orbital bands. Additional considerations for choosing orbits include launch costs and vulnerability to known antisatellite weapons. It is generally more expensive to place satellites in higher orbits; however, high orbits make satellites less susceptible to potential enemy destruction.

The following table illustrates how altitude influences the purposes for which satellites are employed.

TABLE 1[22]

ALTITUDE	PURPOSE
90-300 mi	High resolution imaging recon.
300-630 mi	Survey wide areas incrementally. Environmental, weather,navigation and communications systems.
630-1,250 mi	Surveillance, communications, and electronic monitoring
3,100-6,200 mi	Scientific experiments
6,200-13,700 mi	Navigation
21,750-22,750 mi	Commo, data relay, surveillance, and weather observation by geosynchronous satellites

Other descriptive terms useful to understanding satellite characteristics are as follows:

*GROUND TRACK is a satellite's path superimposed over the earth's surface during each revolution. It is sometimes referred to as "earth trace."

*APOGEE is an orbit's most distant point from earth.

*PERIGEE is an orbit's closest point to earth.

*REVOLUTIONS PER DAY refers to the number of times the earth is circled.

*REVISIT TIME is the time between successive returns to specific points on the earth's surface.

*DWELL TIME is the time a satellite remains in orbit over a specific point on the earth's surface.

*ORBITAL PERIOD refers to the length of a complete orbit. Low orbit satellites have about 90 minute orbital periods while higher orbits take longer.[23]

Satellites remain in specific orbits because of their speed and the influences of the forces of gravity. They do not exist in a weightless environment; rather, they are constrained by the physics of space. Some satellites can be maneuvered slightly using on-board fuel and thrust motors to maintain their precise orbits. However, because of the high velocities involved, it is more difficult and fuel exhausting to influence adjustments in altitudes and lateral relocation into different orbits.[24]

The physics of space influence the strategies for deploying and sustaining satellite systems. Terrestrial commanders must understand that satellite coverage over specific regions of the earth may last as little as nine minutes or be almost continuous depending on the type orbit. Further, the field of view, which is limited by a satellite's altitude and inclination, also affects the space platform's utility. For example, a communications satellite will generally cover an area between 70 degrees north-south latitude. Therefore, military forces

operating in the far northern or southern latitudes may not be able to utilize these systems.[25]

Space physics also make satellite systems vulnerable to detection, disruption, and destruction. Because space forces provide critical force enhancement support to terrestrial commanders, they become viable targets for interdiction by an enemy. The course and outcome of terrestrial battles can be significantly influenced by attacks which successfully destroy or degrade space systems.[26]

Table 2 is extracted from Secretary of Defense Dick Cheney's January 1991 Annual Report to the President and the Congress. It shows the orbits and purposes of the various National Security Satellites.

TABLE 2[27]

U.S. NATIONAL SECURITY SATELLITES

SATELLITES	ORBIT	PURPOSE
FLTSATCOM/AFSATCOM	GEOSYNCHRONOUS	MOBILE COMMO
LEASAT	GEOSYNCHRONOUS	MOBILE COMMO
DSCS II & III	GEOSYNCHRONOUS	HIGH DATA COMMO
SDS	ELIPTICAL	COMMO/COMMO RELAY
DMSP	POLAR	GLOBAL WEATHER
TRANSIT	POLAR	NAVAL NAVIGATION
GPS	MEDIUM EARTH	NAVIGATION
DSP	GEOSYNCHRONOUS	MISSILE WARNING
NATIONAL SECURITY	ALL	TREATY MONITORING

SPACE AND AIRLAND DOCTRINE

The AirLand Battle-Future doctrine evolving within the Army continues to orient on the critical nature of land strategy as the linchpin of joint warfare planning and execution. The umbrella concept under which the doctrine is being developed expands the emphasis on the need for military strategies for both combat and noncombat operations.

The AirLand Battle-Future Umbrella Concept has a global perspective of an Army that will have to respond to protecting U.S. national interests in the various regions of the world. The strategies to apply military forces will sometimes shift rapidly based on the relative importance of the regions to our national interests.[28]

One of the greatest challenges which confronts the military as we move into the last decade of the twentieth century is determining what resources and support structures are needed to achieve our national strategic aims. The reduced threat of nuclear or global high intensity conflict is shifting the Army's orientation from forward deployment of forces to one of forward presence. Force structure is being reduced by 25 percent from Fiscal Years 91 through 95. These reductions are having a profound impact on the way the Army refines its warfighting doctrine and determines how the forces should be organized and equipped.

Studies by the U.S. Army Training and Doctrine Command (TRADOC) have identified future trends which will focus our doctrinal requirements. Technology has dramatically increased

weapons lethality, range, and accuracy. But, at the same time, technological advances have significantly increased the costs of these weapons which leads to the conclusion that the future battlefield will have far more sophisticated weapons, but their numbers will be limited by costs.[29]

AirLand Battle-Future envisions a battlefield where tactical forces will operate in an open, fluid environment. Smaller armies will lead to fewer forces directly confronting each other, but with much more lethal weapons systems. Larger gaps between forces will be more common. Commanders will have to follow the principle of mass at critical points on the battlefield to concentrate combat power while taking greater risks in uncovered areas. The ability to survive and win will depend on a unit's ability to effectively move from dispersed locations clandestinely and rapidly over multiple routes to critical mass points.[30]

The battlefield will be extended by long-range intelligence and long-range, accurate fires. Space sensors will be combined with terrestrial reconnaissance assets to detect and track the enemy in a detection zone that extends as far as 400 kilometers forward of a 100 kilometer deep main battle zone.[31]

Future operations are categorized in four stages:

*Detection-preparation.

*Establishing conditions for decisive operations.

*Decisive operations.

*Reconstitution.[32]

Detection-preparation begins with the use of reconnaissance and surveillance assets from the national level on down to locate, identify, and verify enemy activity. These same forces provide security to the tactical units as they prepare, plan, and train for combat from dispersed locations. During this phase, units will be task organized and logistics requirements will be tailored in accordance with the mission. The detection-preparation phase culminates with the senior commander's (Corps) decision on a course of action which is designed to seize and maintain the initiative.[33]

Establishing conditions for decisive operations implies shaping the battlefield by attriting the enemy and denying him the flexibility to maneuver to mass his forces against friendly vulnerabilities. Tactical air, the Army tactical missile systems (ATACMS), other long-range fires, electronic warfare assets, and helicopter forces are employed against critical enemy targets in the battle and detection zones.[34]

During this phase, space systems play a critical role in targeting, locating obstacles, analyzing terrain, determining mobility corridors, and camouflaging command and control locations and procedures. And, as was evidenced during Operation Desert Storm, providing security against theater tactical ballistic missiles is a primary mission for space surveillance systems during all phases of the battle.

The decisive operations stage is highly dependent on maneuver to position forces where they gain an advantage against enemy capabilities. Distance and speed will increase for future

forces who attempt to achieve offensive breakthroughs or defensive spoiling attacks. Risk taking will become more prevalent for smaller tactical unit commanders as they move their forces to generate combat power at critical points.[35]

Space systems are vital to a commander's ability to effectively maneuver during this phase. They will provide intelligence reporting necessary to key on the enemy, position locating to move great distances without getting lost, and flexible communicating required for mobile command and control.

During reconstitution, the final stage, units again disperse, establish security, and prepare for further operations. Space systems will again be employed for security and reconnaissance. Space-based communications nets for logisticians will be prioritized to accommodate resupply and maintenance operations in a several hundred kilometer square logistics area. GPS systems will be used extensively to locate equipment needing repair and to navigate at night across great distances to resupply the dispersed tactical forces.

One thing is for certain, the Army must seek to incorporate concepts, techniques, and equipment that enhance combat power and the ability to project it at reduced costs in manpower and dollars. The proverbial need for "more bang for the buck" concept is more appropriate now than ever.

Space systems offer the Army the means to support tactical operations with fewer manpower and equipment resources. Especially important are the force enhancement capabilities of

space assets to support non-linear oriented ground forces as perceived in AirLand Battle-Future.

As the Army evolves its future warfighting doctrine, it will continue to build on the fundamental concepts that describe how ground forces generate and apply combat power at the tactical and operational levels. These key concepts are embodied in FM 100-5, Operations, as the tenets and imperatives of AirLand Battle doctrine.

Army commanders will have to be trained in the application of the tenets and imperatives within the context of a future doctrine which seeks to incorporate the technological advances in military hardware and their impact on the battlefield. Space will play an increasingly important role in the Army's warfighting concepts because of its unique capabilities as a force multiplier and enhancer. Yet the roles and functions performed by space forces are oftentimes underemphasized in the Army's education and training programs. This may be due to misperceptions that space subjects are complicated, difficult to understand, and best left in the hands of specialists. If this is the case, perhaps it would be prudent to teach the subject of space support within the context of how it applies to AirLand Battle Doctrine and how it enhances the commander's chances for success on the battlefield.

The fundamental tenets of AirLand Battle are: initiative, agility, depth, and synchronization. They describe the characteristics of successful military operations. These tenets are supplemented by key operating requirements which prescribe

fundamentals which are necessary for success on the modern battlefield. These operating requirements called imperatives are:

*"Ensure unity of effort.

*Anticipate events on the battlefield.

*Concentrate combat power against enemy vulnerabilities.

*Designate, sustain, and shift the main effort.

*Press the fight.

*Move fast, strike hard, and finish rapidly.

*Use terrain, weather, deception, and OPSEC.

*Conserve strength for decisive action.

*Combine arms and sister services to complement and reinforce.

*Understand the effects of battle on soldiers, units, and leaders."[36]

INITIATIVE

"Initiative means setting or changing the terms of battle by action. It implies an offensive spirit in the conduct of all operations."[37] When a commander takes the initiative, he sets the tempo of the battle and forces the enemy to react to his actions.

Key to taking and maintaining the initiative are intelligence operations which provide information about the enemy and his likely courses of action. Knowledge of the enemy enables

a commander to extensively plan how he will shape the battlefield to maximize the effects of his tactics with minimum risk to loss of friendly men and equipment.

Satellites can provide commanders with the means to collate electronic, signals, imagery, and communications intelligence with human intelligence sources to paint a composite picture of an enemy's disposition and capabilities and, thus, anticipate events on the nonlinear battlefield. Operational commanders can use this information to disperse joint forces throughout the depth of the theater of war to set the conditions for tactical battles.

At the tactical level, commanders can use intelligence information from space systems to place forces in dispersed, noncontiguous areas from which enemy forces are vulnerable to attack. Destruction of the enemy forces is emphasized over terrain retention.[38]

Space forces can enable the operational and tactical commanders to define the parameters of the nonlinear battlefield. This would allow commanders to seize the initiative to concentrate combat power against enemy vulnerabilities and force the pace and direction of battle. Enemy gaps in the lines, breaks in lines of communications and obstacles to mobility can be identified and exploited, making it easier to designate, sustain, and shift the main effort.

Real-time intelligence and target acquisition from space forces allow commanders to identify opportunities for offensive actions. Gaps in lines can be identified for breakthrough

operations, counterattacks, or for spoiling attacks. Communications satellites provide leaders the means to rapidly transmit orders and information throughout the depth of the theater unencumbered by terrain restrictions inherent in ground based communications systems. Dependence on satellite communications becomes more important as the distances between forces increases.

AGILITY

Agility is "the ability of friendly forces to act faster than the enemy."[39] It comes from a commander's ability to "read the battlefield" and respond quickly to opportunities and changing requirements. Frequently, this necessitates action to overcome the confusion of battle by relying on incomplete information. Risk is inherent in the tenet of agility. Space systems can be used to gain information which reduces the degree of risk to which a commander subjects his unit.

Mobility is the critical link between initiative and agility. It determines whether available forces can actually be maneuvered to take advantage of vulnerabilities identified by intelligence sources. Weather, terrain, and obstacles affect mobility and must be analyzed in detail to develop appropriate schemes of maneuver.

Weather and environmental satellites, such as LANDSAT, provide the means for gathering accurate terrain and trafficability information. This information can be fused with data from reconnaissance satellites that identify obstacles and

enemy locations. The product is a thorough terrain and trafficability analysis that identifies the best avenues of approach into the enemy and enables friendly forces to move fast, strike hard, and finish rapidly. Units will be able to use the products of environmental and GPS satellites to conduct predeployment rehearsals on maps which are only hours old.

The nonlinear battlefield makes offensive operations more difficult to execute and sustain. There are greater inherent risks associated with moving units over large distances to out-maneuver enemy forces. POS/NAV satellite systems reduce the chances of forces getting misoriented and enable commanders to track movements of units over multiple routes.

The focal point is on enemy force concentrations as opposed to key terrain. Maneuver is emphasized to avoid head-on attacks and instead, hit the enemy on his flank or rear. Long-range intelligence from RSAT space systems provides critical information on enemy vulnerabilities.

Integration of data from RSAT, weather, environmental, COMSAT, and POS/NAV space systems allows commanders to use terrain, weather, deception, and OPSEC to mass and attack at the critical time and place against the enemy's center of gravity. Agility is enhanced by providing data about the enemy and friendly situations that make it easier to tailor forces for tactical superiority over the opponent at the critical time and place.

DEPTH

"Depth is the extension of operations in space, time, and resources. ... Momentum in the attack and elasticity in defense derive from depth."[40] Reconnaissance in depth provides information on committed, reinforcing, and reserve enemy forces. Commanders seek to engage the enemy throughout the spectrum of his dispositions to deny enemy freedom of action and disrupt his flexibility.

Nonlinear battlefields place a great premium on the use of satellites to locate and track the enemy over long ranges. The tactical commander will designate battle areas and detection areas within his area of operations. The battle area is where he plans to destroy the enemy force. The detection area extends in all directions in which the enemy might operate to influence the battle. It is in this detection area that space forces can provide intelligence about potential enemy activities which might affect current or future operations.[41]

In AirLand Battle-Future, the battlefield depth is expressed in hundreds of kilometers: 100 for the battle zone and another 400 for the detection zone. Space systems are the only assets which can surveil the entire battlefield and provide the multiplicity of data needed for intelligence, weather and environment, targeting, navigation, and command and control.

The deep detection zone will be the operating province for Special Operations Forces (SOF) and other clandestine reconnaissance units. These personnel will require direct access to space assets to facilitate their deployments and relay

information to the main battle forces. RSAT's can be used by SOF units to gain information about the enemy and also to analyze the effectiveness of their own camouflage and deception techniques as viewed from space.

Desert Storm proved that indirect fire weapons such as cruise missiles can be utilized to attack targets several hundred kilometers away with pinpoint accuracy. It would seem logical that cruise-type weapons will be added to Army long-range fire capabilities provided by ATACMS and enhanced multiple launch rocket systems (MLRS). Future indirect fire weapons systems will rely on terrain and navigation data from space systems to achieve precision guidance to distant targets. Another possibility is the use of satellites as designators for laser-guided direct and indirect fire weapons systems.

Knowledge of what is happening on the flanks, on the far front, and in the rear allows the commander to protect his own vulnerabilities while conserving strength for decisive action against enemy weaknesses. The ability to exploit this knowledge depends on rapid communication of instructions to friendly forces who are dispersed throughout the area of operations. Use of SATCOM nets makes friendly communications less susceptible to jamming and interception by the enemy.

SYNCHRONIZATION

"Synchronization is the arrangement of battlefield activities in time, space, and purpose to produce maximum relative combat power at the decisive point."[42] It is an

accumulating of forces, fires, maneuver, interdiction, and supporting activities in a coordinated effort to combine resources from all directions and sources at the decisive time and place. The synergistic effects of joint and combined operations reinforce one another and ensure unity of effort in the application of combat power.

Synchronization will be the most complex tenet of AirLand Battle-Future. Distances between units are magnified by friendly unit operations to disperse, camouflage, reduce electronic signatures, and deceive the enemy. Commanders will be faced with having to integrate long-range indirect fires and support operations with complicated maneuver by air, ground, and sea forces over a battlefield several hundred kilometers deep. Synchronization will depend on command and control achieved while commanders are moving rapidly as opposed to communicating from fixed or semi-fixed locations. Communications satellites will be the backbone of the command and control system.

Should the United States ever develop a capability to provide fire support from space platforms, their employment would be synchronized with forces from terrestrial systems in order to combine arms and sister services to complement and reinforce principal maneuver forces. Space forces provide rapid access to real-time intelligence and allow information to be shared by complementing and reinforcing units. Space systems by themselves integrate the tasks normally performed by diverse activities, freeing terrestrial forces for other missions.

Another future, expanded use of space systems is in the electronic warfare arena. Space-based radar and communications interceptors and jammers can be employed to confuse and disrupt enemy forces. Actions to divert enemy intentions can be synchronized with direct and indirect fires from land, air, sea, and space to press the fight in a unified effort to destroy the opposition.

Indeed, every facet of battlefield organization, from deployment and intelligence preparation of the battlefield (IPB) which establish conditions for decisive operations through the decisive operations and reconstitution stages as postulated in AirLand Battle-Future, requires synchronization which can only be achieved by integrating the resources and products of space systems. Communications, navigation, surveillance, environmental, and space weapons satellites must all be fused into a mosaic picture which penetrates the "fog of battle" and depicts the battlefield in as simple a manner as possible. After all, it is simple soldiers that ultimately will have to close with and destroy the enemy.

CONCLUSION

Space forces have long been used as part of the national assets deployed in support of strategic deterrence missions. Within recent years we have seen a gradual shift from the exclusive use of space systems at the national level to expanding utilization by warfighting forces. It is only in the last decade

that we have begun to fully exploit the capabilities of space at the operational and tactical levels. For example:

*In 1986, information from space systems was used to prepare U.S. pilots for the air strikes against Libya.

*In 1987, GPS was used by U.S. ships and helicopters to conduct mine-clearing operations in the Persian Gulf.

*In 1990 and 1991 satellites were used to support all facets of Operations Desert Shield and Desert Storm. MILSATCOMS provided inter and intra theater communications links for forward deployed units and their home bases. DMSP satellites facilitated overseas movements. Environmental satellites were used to provide terrain data which could be merged with GPS information to produce topographic maps. Surveillance satellites provided tactical commanders with ballistic missile launch warning and timely information about the enemy. GPS was used to aid navigation.[43]

Because space systems have been a critical component of our national nuclear deterrence strategy, there has been a tendency to compartmentalize many of their products and limit their release to lower level commanders. This over-classification of space assets has bred a generation of officers who have been denied access to vital decisionmaking tools. Further, these same officers have become skeptical that space systems will not remain commandeered at the National level.

Satellite systems, particularly those used for national security, are extremely expensive to deploy, operate, and maintain. There has been much recent debate on the feasibility

of developing cheaper tactical satellite systems (TACSATS) which can be deployed for specific missions in support of designated theaters of operations. The shrinking defense budget may force closer cooperation between National level users and tactical level commanders over the use of limited space resources.

The Army faces a major challenge in being able to articulate force requirements needed to support AirLand Battle-Future doctrine. Army planners need to conceptualize and program satellite systems which support regional contingencies and are available on a full-time basis to tactical commanders. Army involvement in these systems must be prevalent from their inception.

AirLand Battle-Future doctrine predicts a battlefield environment which will require extensive access by operational and tactical commanders to space assets. These commanders and their staffs must be familiar with space systems capabilities so that they can maximize their employment and minimize their abuse or misuse. Yes, satellites can be abused if, for example, their communications circuits are overloaded or if the source of their products is compromised.

Space subjects should be integrated more strongly into the Army officer education system at all levels from the pre-commissioning programs through the Army War College. The focus should be on how space forces support day-to-day operations and how they are employed for tactical missions.

To be most effective, space systems should be employed in field training and wargaming exercises. Conceptualizing space forces in terms of AirLand Battle tenets and imperatives can provide useful guidelines to commanders for integrating space assets into campaign and battle planning.

Finally, the Army subscribes to the concept that doctrine drives equipment research and development. Given AirLand Battle-Future reliance on space, it would seem most appropriate and beneficial to give space more visibility by renaming the doctrine to AeroSpaceLand Battle-Future.

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